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Antiepileptic Drug Prescribing Patterns and Seizure Control Among Outpatients with Epilepsy at a Public Hospital in Indonesia

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ABSTRACT: Background: Epilepsy affects nearly 50 million people globally, including approximately 700,000–1.4 million in Indonesia, with 70,000 new cases reported annually. Objective: This study aimed to determine antiepileptic drug (AED) prescribing patterns and to examine their association with seizure control outcomes in patients with epilepsy. Methods: A descriptive cross-sectional analysis was conducted using 185 outpatient prescriptions. Data on patient demographics, seizure frequency, and AED regimens were collected. Patterns of monotherapy and polytherapy were analyzed descriptively, and seizure control was compared using chi-square analysis. Results: Of the patients evaluated, 48.6% were male and 51.4% female. Monotherapy was prescribed in 51.4% of patients, predominantly valproic acid (VPA) and phenytoin (PHT). Polytherapy was used in 48.6% of patients, with the most common combinations being VPA + carbamazepine (CBZ) and PHT + VPA. Seizure-free control within six months was achieved in 34.6% of patients. A significant association was found between therapy regimen and seizure control ($p = 0.040$), with poor control more frequent in polytherapy (73.3%) than monotherapy (57.9%). Patients on polytherapy had twice the risk of poor seizure control (OR = 2.00; 95% CI: 1.08–3.72). Conclusion: Valproic acid remains the most prescribed AED for monotherapy, while phenytoin–valproic acid combinations are frequent in polytherapy. Polytherapy was associated with poorer seizure control, highlighting the importance of individualized AED selection and rational drug utilization in epilepsy management.

Keywords: **antiepileptic drugs; prescribing pattern; seizure control; drug utilization; real-world evidence.**

Introduction

Epilepsy is one of the most prevalent neurological disorders, affecting nearly 50 million people worldwide and more than 3 million people in the United States [1]. Genetic disorders or brain injuries may contribute to epileptic seizures, though in most cases, the cause remains unknown [1]. In Indonesia, the estimated number of epilepsy cases ranges between 700,000 and 1.4 million, with approximately 70,000 new cases each year [2]. The average prevalence of epilepsy in Indonesia is 8.2 per 1,000 population, with an incidence rate of 50 per 100,000 population [3]. In Central Java, epilepsy accounts for about 30.42% of neurological cases [4], and in 2023 there were 4,155 epilepsy patient visits in one of the provincial hospitals. Furthermore, the cost of epilepsy medications in Indonesia remains high even for patients covered by national health insurance [5].

Antiepileptic drugs (AEDs) are the mainstay of epilepsy therapy, aiming to control or reduce seizures, minimize side effects, and improve quality of life [6,7]. Monotherapy is generally preferred as the first-line treatment because it has a better tolerability profile, promotes adherence, and reduces costs compared to polytherapy [6]. However, when seizure control is not achieved, a combination of drugs (polytherapy) may be required. The administration of AEDs must carefully balance benefits and risks; for example, valproic acid provides broad-spectrum seizure control but carries a risk of hepatotoxicity and teratogenicity in women of childbearing age [8]. In addition, ensuring the availability of appropriate drugs is essential to maintain continuity and effectiveness of therapy [8].

Currently, more than 30 AEDs are available, each differing in pharmacokinetic properties, mechanisms of action, efficacy, and side effects [9]. Therefore, treatment must be individualized. However, the use of multiple drugs with similar mechanisms or metabolic pathways can increase the risk of adverse effects and drug

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interactions [10,11]. Prolonged treatment duration, frequent dosing, and adverse drug reactions are among the challenges in long-term epilepsy management.

Various factors influence the pattern of AED prescribing in hospitals, including clinical guidelines, physician preferences, drug availability, and patient characteristics [12]. Previous studies have shown that monotherapy (e.g., valproic acid or clobazam) can control seizures in about 40% of patients, while approximately 60% require combination therapy for adequate seizure control [12]. However, data on real-world prescribing patterns and seizure outcomes in Indonesia remain limited, especially in public hospital settings.

This study aims to analyze the prescribing patterns of antiepileptic drugs (AEDs) based on patient characteristics including gender, age, and therapy regimen, and to examine their association with seizure control outcomes. Specifically, this study tested the hypothesis that patients receiving polytherapy have a higher risk of poor seizure control compared with those receiving monotherapy.

Methods

Study Design

This analytical observational study employed a cross-sectional design and was conducted over a three-month period at Dr. Moewardi Regional General Hospital, Surakarta, Indonesia. The primary objective was to determine the prescribing patterns of antiepileptic drugs (AEDs) used for seizure control in epilepsy treatment. Secondary objectives included: (1) describing the distribution of AED prescriptions by gender; (2) comparing prescribing patterns between pediatric and adult patients; (3) identifying the most common AED combinations; (4) evaluating seizure control outcomes categorized as good (no seizures in the past six months) or poor (at least one seizure in the past six months); and (5) analyzing sociodemographic, clinical, and medication factors associated with seizure control.

The final sample consisted of 185 patients, determined using a purposive sampling approach that included all eligible patients who met the inclusion criteria. This sample size was considered adequate based on feasibility and representativeness of the outpatient population attending the neurology clinic during the study period.

Ethical Statement

This study was approved by the Health Research Ethics Committee of Dr. Moewardi Regional General Hospital, Surakarta (Approval No. 1.484/VI/HREC/2024). All participants provided written informed consent prior to inclusion.

Population and Sample

The study population was all patients suffering from epilepsy and receiving antiepileptic drugs who came for follow up treatment in June-August 2024 at the neurology clinic of Dr. Moewardi Hospital, Surakarta.

The inclusion criteria in this study were all outpatients with a primary diagnosis of epilepsy at Dr. Moewardi Hospital, patients who had received antiepileptic drugs for at least 1 month, and had complete medical record data including patient name, medical record number, gender, patient age, concomitant disease, history of medication use, type of antiepileptic and patients were willing to participate in the study by signing an informed consent.

Data Collection

Data were collected retrospectively from medical records of eligible patients. Recorded variables included demographic information (age, gender), clinical characteristics (comorbidities, seizure frequency), and medication details (type, dosage, and regimen of AEDs).

Data on antiepileptic therapy included only oral antiepileptic drugs prescribed for continuous outpatient use. Injectable drugs administered solely for acute seizure control were not included.

Data were tabulated using Microsoft Excel for data entry and subsequently analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Data Analysis

The research data were analyzed using descriptive statistics. The variables assessed were gender, age, good and poor seizure control, and monotherapy and polytherapy, which will be processed into tables and diagrams showing the number and percentage.

Bivariate analysis is used to examine the relationship between predetermined predictors and seizure control. The assumptions for Chi-square analysis (expected frequency ≥ 5) were checked prior to testing. When this assumption was not met, Fisher's Exact Test was applied. A p-value <0.05 was considered statistically significant, with a 95% confidence interval (CI). Researchers conducted data analysis with the SPSS computer program.

Result and Discussion

Demographic Analysis

This study enrolled a total of 185 epilepsy patients, consisting of 95 females (51.4%) and 90 males (48.6%). The mean age of patients was 19.76 ± 16.01 years (range: 1–69 years). The majority of patients were in the 0–20 year age group (62.7%), followed by 21–50 years (30.3%), and only 7% were aged over 50 years (Figure 1). Table 1 summarizes the demographic characteristics of the study population.

The predominance of younger patients (≤ 20 years) in this cohort aligns with existing evidence that approximately 50% of epilepsy cases occur during early life, particularly within the first 10 years of age [12]. The developing brain in children and adolescents has a higher susceptibility to seizures due to immature ion homeostasis, neurodevelopmental variability, and complex etiologies [12].

In terms of therapeutic patterns, previous studies have reported that carbamazepine, valproic acid, clobazam, phenytoin, and phenobarbital remain the most effective AEDs for newly diagnosed epilepsy across all age groups and seizure types, with no significant difference in efficacy or adverse effects among them [13]. A study conducted by Aditya et al. (2023) further highlighted that valproic acid, phenytoin, and carbamazepine are the most commonly prescribed AEDs in Indonesia, either as monotherapy or combination therapy [14]. The present study was consistent with this trend, as these drugs were also the most frequently used among epilepsy outpatients in the neurology clinic of Dr. Moewardi Regional Hospital.

The demographic pattern observed indicates that epilepsy predominantly affects younger populations in this study setting, emphasizing the importance of early detection and management. Before deciding to use antiepileptic drugs AEDs), clinicians should carefully weigh the potential for recurrent seizures, psychosocial and occupational consequences, and treatment side effects. The ultimate goal of epilepsy management is to achieve "seizure-free, side-effect-free" outcomes to optimize patients' quality of life [15]. Moreover, the findings underscore the need for rational AED selection based not only on electroencephalographic profiles but also on individualized treatment responses and tolerability [16].

Utilization of Antiepileptic Drugs by Gender

There were observable differences in the utilization patterns of antiepileptic drugs (AEDs) between genders, as presented in Figure 2. Valproic acid (VPA) and phenytoin (PHT) prescriptions were more frequent among male patients, while levetiracetam (LEV) and lamotrigine (LTG) were more commonly prescribed for female patients. In terms of combination therapy, men were more likely to receive VPA + carbamazepine (CBZ), whereas women more frequently used VPA + PHT.

These findings are consistent with existing evidence suggesting that the choice of AEDs often differs between genders due to safety and pharmacological considerations. Men tend to use PHT and VPA more frequently because

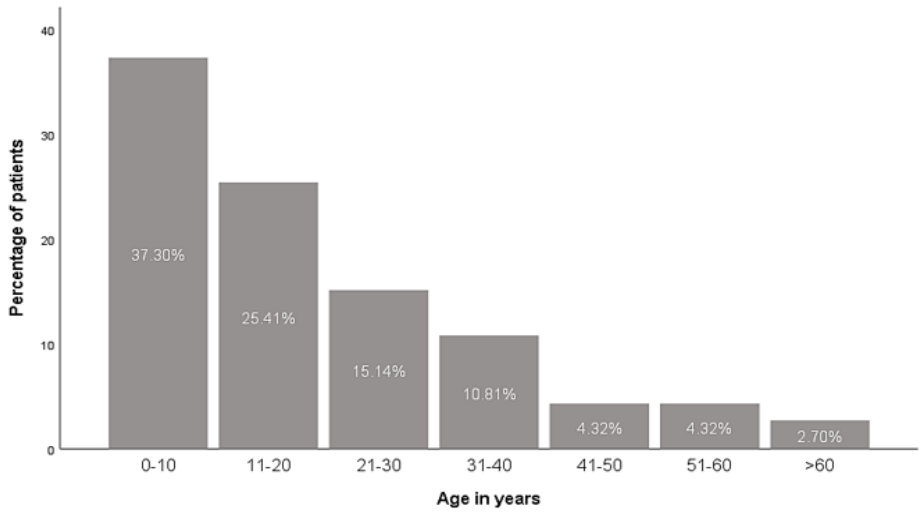

Figure 1. The bar chart illustrates the percentage of patients with epilepsy across 10-year age intervals (n = 185). Age distribution by age group (0–10, 11-20, 21–30, 31-40, 41-50, 51-60, and >60) among epilepsy patients.

Table 1. Demographic and clinical characteristics of 185 patients taking antiepileptic drugs were included in the analysis.

Parameters	Number of Patients (%)
Gender	
Male	90 (48.6)
Female	95 (51.4)
Age	
Mean (SD)	19.76 (16.01)
Median (range)	15 (1-69)
Seizure Control	
Good (seizure free ≥ 6 months)	64 (34.6)
Poor (seizure free < 6 months)	121 (65.4)
AED treatment regimens	
Monotherapy (1 AED)	95 (51.4)
Polytherapy (> 1 OAE)	90 (48.6)

these drugs pose teratogenic risks that make them less suitable for women of childbearing age [17,18]. Conversely, CBZ, LEV, and LTG are preferred in women due to their comparatively safer reproductive profile [17,18].

Furthermore, previous studies have reported that women are more likely than men to develop treatment-resistant epilepsy, with approximately a 27% higher risk of AED resistance within the first year of therapy. This difference is largely attributed to variations in pharmacokinetics and pharmacodynamics between sexes, as well as the influence of endogenous hormones and concurrent medications affecting AED metabolism [19]. The high frequency of VPA prescriptions observed in this study may also reflect its established efficacy in pediatric epilepsy, consistent with prior findings that VPA demonstrates superior control of generalized seizures in younger populations compared to PHT and several other AEDs [20].

The observed gender-based differences in AED prescribing patterns highlight the importance of personalized pharmacotherapy in epilepsy management. Gender-specific factors including teratogenicity, hormonal influences, and differential drug metabolism should be integral to clinical decision-making. In particular, for female patients of reproductive potential, clinicians should prioritize AEDs with a lower risk of teratogenicity and hormonal interaction, while still maintaining optimal seizure control. Such considerations are essential for achieving safer and more effective individualized epilepsy treatment strategies.

Utilization of Antiepileptic Drugs in Children and Adults

Patients were categorized into children (≤18 years) and adults (>18 years). The results revealed significant age-related differences in AED prescribing patterns. Valproic acid (VPA) prescriptions were notably higher in children, whereas phenytoin (PHT) was more frequently prescribed in adults. Pediatric patients did not receive carbamazepine (CBZ), levetiracetam (LEV), or lamotrigine (LTG). Among children, the most frequent polytherapy combination was VPA + CBZ, while adults predominantly received PHT + clobazam (CLB). Other combination regimens showed no significant differences between age groups (Figure 3). Overall, the most commonly prescribed AEDs in children were VPA > PHT > CBZ > CLB > topiramate (TPM) > phenobarbital (PHB), whereas in adults the sequence was PHT > LEV > VPA > CBZ > CLB > TPM.

The predominance of VPA prescriptions in pediatric patients aligns with prior studies conducted in Indonesia, which reported valproic acid as the most frequently prescribed antiepileptic medication in children [10]. VPA's broad-spectrum efficacy and relatively favorable safety profile make it suitable for various seizure types in the pediatric population, including infantile epilepsy syndromes such as Dravet syndrome and myoclonic epilepsy [21,22]. It has also been used off-label in neonates due to its versatile antiepileptic properties [21].

In contrast, adults more frequently received PHT, consistent with previous research highlighting its effectiveness in controlling tonic-clonic and complex partial seizures, as well as its utility in managing status epilepticus both intravenously and orally [23]. Despite

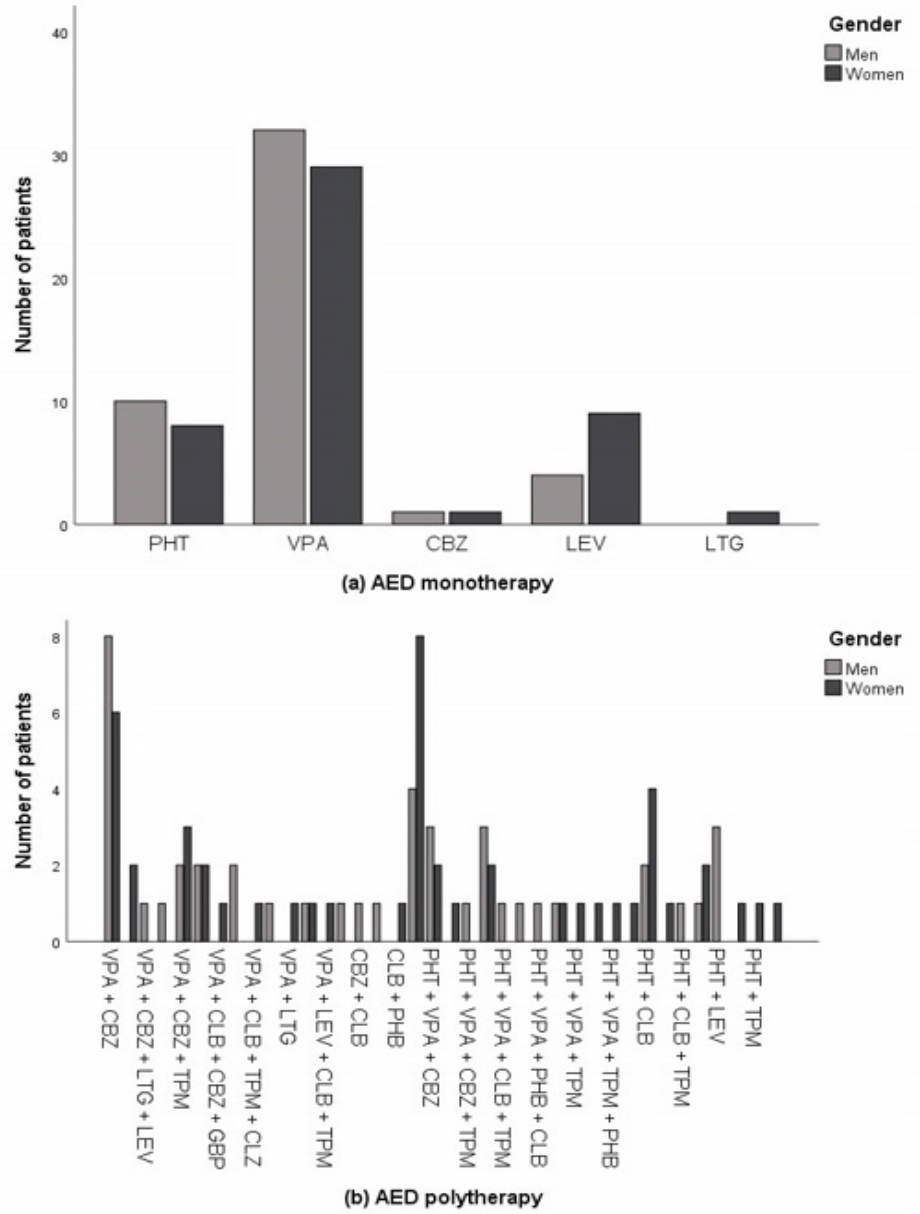

Figure 2. Distribution of AED use by gender. (a) Monotherapy: VPA was most frequently prescribed, followed by PHT and LEV. CBZ and LTG were less common. (b) Polytherapy: VPA-based combinations, especially with PHT, were predominant in both genders. Data represent the total epilepsy population (n = 185).

its efficacy, phenytoin therapy is associated with a range of adverse effects including nystagmus, ataxia, sedation, gum hyperplasia, and cognitive changes as demonstrated by AlMulihi et al. (2023) [24]. Long-term use of PHT may also decrease bone density and cause rare but severe hypersensitivity reactions, thus necessitating regular monitoring and individualized dosing [24].

The observed age-based variations in AED utilization emphasize the importance of tailoring epilepsy management according to developmental and physiological differences. In pediatric patients, the preference for VPA reflects the need for broad-spectrum seizure control and minimized adverse effects in a growing population. Meanwhile, in adults, the continued reliance on PHT underscores its established efficacy and accessibility, though its long-term toxicity profile requires vigilant clinical supervision. These findings highlight the necessity of individualized AED selection that considers patient age, seizure type, comorbidities, and tolerability. Furthermore, they underscore the potential benefit of expanding access to newer-generation AEDs with improved safety and pharmacokinetic profiles, particularly for pediatric and elderly patients.

Prescribed Antiepileptic Therapy Regimens for Patients with Good Seizure Control

In this study, the proportion of patients who achieved good seizure control was relatively low (34.6%) compared to those with poor control (65.4%). Among pediatric patients, valproic acid (VPA) provided the highest rate of seizure freedom (42.19%), whereas in adults, phenytoin (PHT) was the most effective single agent, achieving seizure control in 9.38% of patients. Regarding combination therapy, the regimen most commonly associated with good seizure control in pediatric patients was VPA + carbamazepine (CBZ) (10.94%), while in adults, the combination of PHT + clobazam (CLB) (4.69%) showed the best outcomes. Notably, levetiracetam (LEV) was not prescribed for pediatric patients achieving good seizure control (Figure 4).

The absence of LEV use in pediatric patients is consistent with prior studies noting its limited application in children due to concerns about behavioral and neurological side effects, such as irritability, aggression,

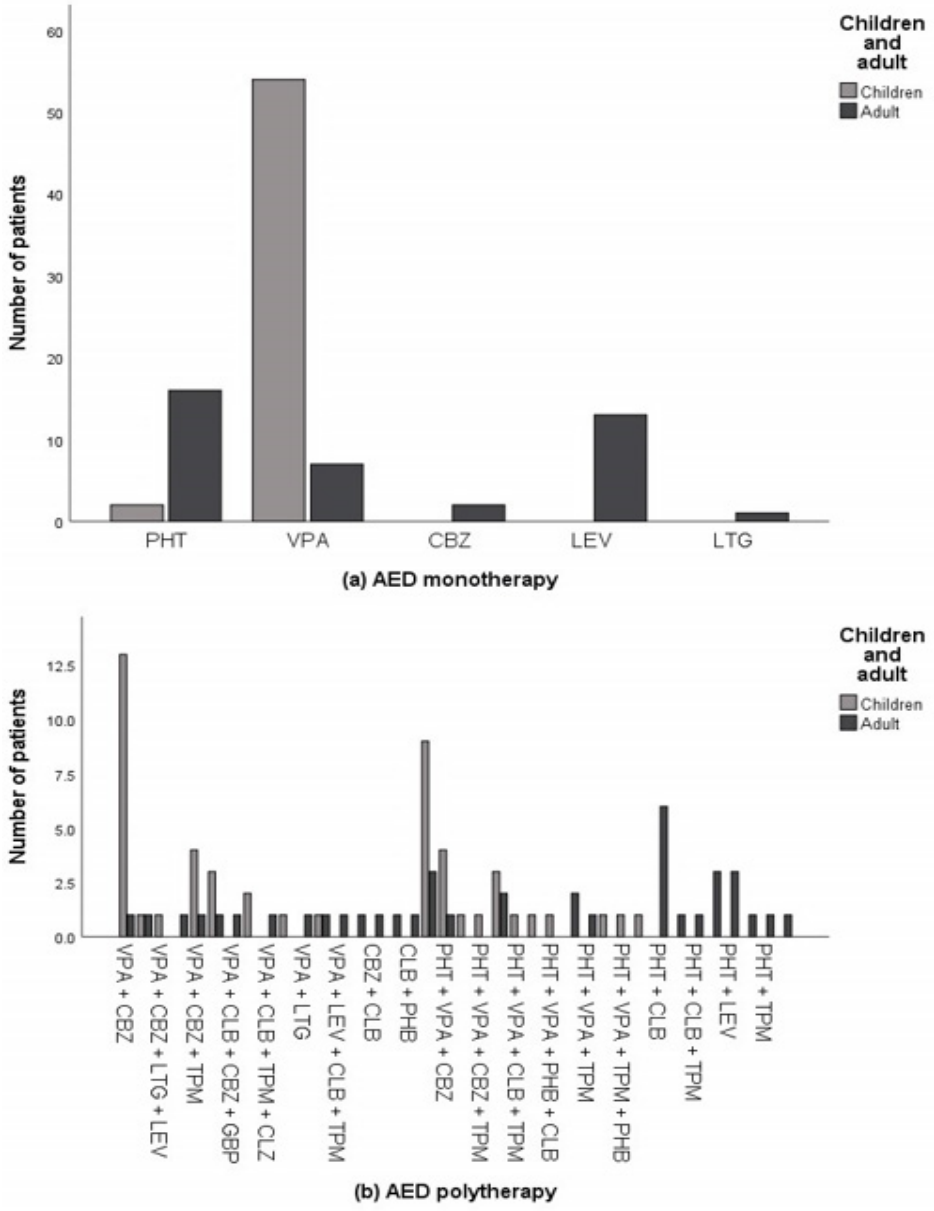

Figure 3. Distribution of AED use in children and adults. (a) Monotherapy: VPA was most used, followed by PHT and LEV. (b) Polytherapy: VPA-based combinations were dominant in both groups, with adults showing higher polytherapy use. Data represent the total epilepsy population (n = 185).

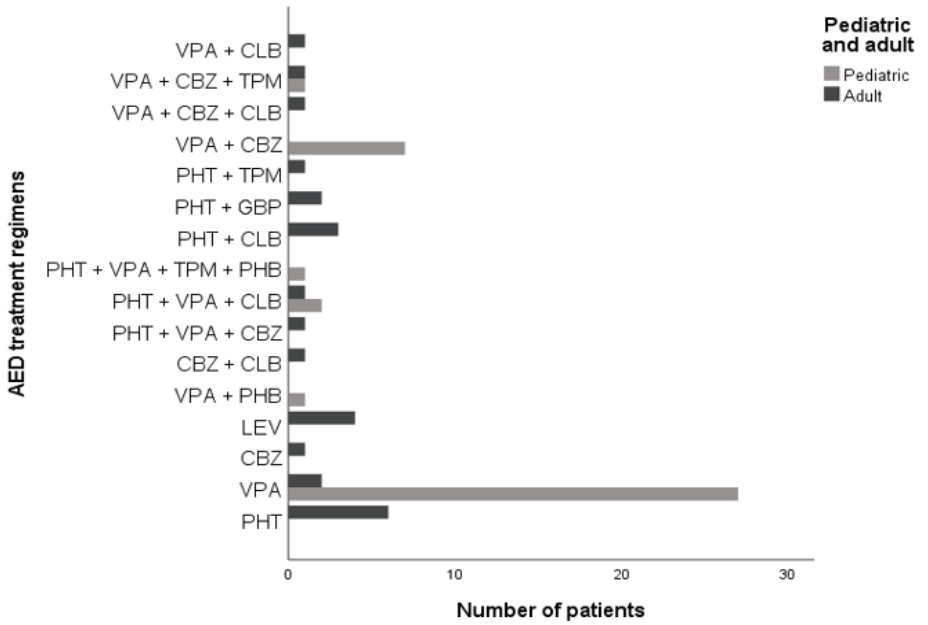

Figure 4. AED regimens associated with good seizure control in children and adults. VPA monotherapy was most common, especially in adults. VPA-based combinations (e.g., VPA + CBZ, PHT + VPA + CBZ) were also frequent. Data represent the total epilepsy population (n = 185).

hyperactivity, and somnolence [25]. These adverse effects tend to occur more frequently in pediatric populations than in adults, potentially limiting LEV's clinical utility in younger patients. Moreover, current evidence on the efficacy of LEV in children particularly in neonates and infants remains limited, and plasma concentration monitoring is difficult due to the unclear correlation between serum levels and clinical response [26].

In contrast, VPA continues to be widely utilized in pediatric epilepsy due to its well-established efficacy and safety in controlling generalized and mixed seizure types. Similarly, CBZ and PHB remain among the preferred options in children because of their predictable pharmacokinetics and well-characterized safety profiles. In adults, PHT's effectiveness in controlling tonic-clonic and partial seizures reinforces its role as a first-line therapy despite the need for close monitoring to manage dose-dependent side effects. This clinical preference is consistent with the latest NICE guidelines 2022 recommendations, which highlight valproic acid as a first-line monotherapy for generalized and mixed seizure types, while levetiracetam is reserved for specific focal-onset cases or when safety concerns with other agents arise [27].

The findings indicate that achieving good seizure control remains challenging, with less than half of patients reaching optimal therapeutic outcomes. This underscores the importance of individualized AED selection based on patient age, seizure type, and drug tolerability. For pediatric patients, the higher success rate with VPA and CBZ highlights the continued relevance of these agents as mainstays in therapy, particularly when balancing efficacy and safety. Conversely, the results suggest that LEV may require more cautious use and further study in pediatric populations to clarify its risk–benefit profile. Clinicians should prioritize optimizing drug selection, dosage titration, and adherence monitoring to improve seizure outcomes. Moreover, future research should focus on identifying predictors of poor seizure control and evaluating newer-generation AEDs with fewer behavioral and pharmacokinetic limitations, especially in children.

Prevalence of Antiepileptic Drug Treatment Regimens on Seizure Control

In this study, 95 patients (51.4%) were treated with monotherapy using a single antiepileptic drug (AED), while 90 patients (48.6%) received polytherapy regimens consisting of two to four AEDs. Among polytherapy users, 51 patients received two-drug combinations, 28 received three-drug combinations, and 11 received four-drug combinations. Valproic acid (VPA) was the most frequently prescribed AED in monotherapy regimens.

As shown in Figure 5, patients treated with monotherapy achieved better seizure control compared to those on polytherapy, whereas poor seizure control

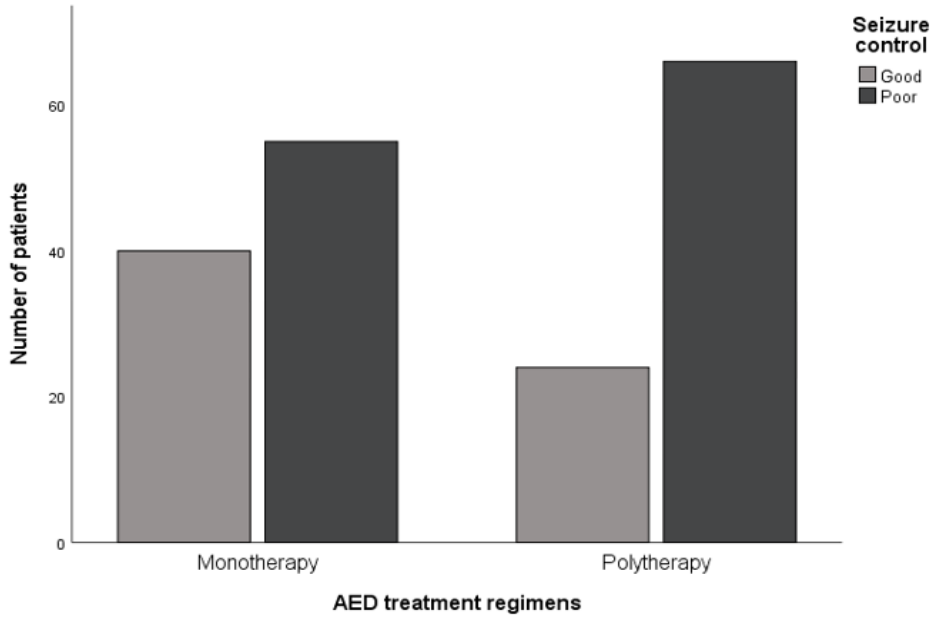

Figure 5. Comparison of seizure control between monotherapy and polytherapy. More patients on polytherapy had poor control, while monotherapy was linked to better outcomes. Data represent the total epilepsy population (n = 185).

was more common in polytherapy users. The prescribing trend indicated that older AEDs such as phenytoin (PHT), valproic acid (VPA), and carbamazepine (CBZ) were used more frequently than newer-generation AEDs like levetiracetam (LEV), lamotrigine (LTG), and topiramate (TPM). Among the newer drugs, LEV was the most frequently prescribed, though its overall use remained limited. Only a few patients received monotherapy with other newer AEDs such as gabapentin (GBP) and TPM.

The predominance of monotherapy observed in this study aligns with previous findings from Indonesia and other Asian countries, where monotherapy remains the preferred approach to epilepsy management [28]. Similarly, the higher frequency of VPA prescriptions is consistent with the study by Joseph et al. (2013), which also reported VPA as the most commonly prescribed AED compared to PHT and CBZ [29].

The preference for monotherapy over polytherapy is well supported in the literature. Monotherapy is generally considered the first-line approach due to its superior tolerability, reduced risk of side effects and drug interactions, and improved patient adherence [30]. Furthermore, monotherapy tends to be more cost-effective and simpler to manage clinically, contributing to better long-term outcomes [31]. In contrast, polytherapy often increases the likelihood of adverse effects, pharmacokinetic interactions, and even seizure exacerbation, potentially compromising patients' quality of life [31].

In Western countries, particularly in Europe, newer AEDs such as gabapentin and topiramate are more widely prescribed [32]. Their broader acceptance is attributed to favorable safety profiles and approval for a variety of seizure types. However, in developing regions, the use of older AEDs remains prevalent, largely due to cost, availability, and clinician familiarity.

The results of this study reinforce the importance of rational AED selection and the prioritization of monotherapy as a standard strategy for optimal seizure control. Monotherapy not only reduces adverse effects and drug–drug interactions but also enhances adherence and minimizes healthcare costs, making it a practical approach in resource-limited settings.

The continued predominance of older AEDs such as VPA, PHT, and CBZ highlights their sustained clinical utility; however, it also underscores the limited accessibility and utilization of newer, potentially safer agents like LEV, LTG, and TPM. Expanding clinician training, patient education, and healthcare policy support for newer-generation AEDs could promote more individualized therapy and improved outcomes in epilepsy management.

Analysis of Demographic Relationship to Seizure Control

Table 2 presents the relationship between demographic factors and seizure control in epilepsy patients. The proportion of patients with poor seizure

Table 2. Bivariate analysis of demographic relationship with seizure control in epilepsy patients (n = 185). Significant values (p < 0.05) are shown in bold.

Variables	Control Seizure		Bivariate Analysis	
	Poor (%)	Good (%)	P-value	OR (95% CI)
Gender				
Female	62 (65.3)	33 (34.7)	1.000	0.987
Male	59 (65.6)	31 (34.4)		(0.538 – 1.810)
Age				
Adult > 18 years	54 (68.4)	25 (31.6)	0.568	1.257
Children ≤ 18 years	67 (63.2)	39 (36.8)		(0.678 – 2.330)
Regimen therapy				
Polytherapy	66 (73.3)	24 (26.7)	**0.040**	2.000
Monotherapy	55 (57.9)	40 (42.1)		(1.076 – 3.717)

control was comparable between females (65.3%) and males (65.6%), with an odds ratio (OR) of 0.987 (95% CI: 0.538–1.810) and a non-significant p-value (p = 1.000), indicating no association between gender and seizure control. Similarly, age did not show a significant association with seizure control (p = 0.568). Adults (>18 years) exhibited a slightly higher proportion of poor seizure control (68.4%) compared to children (≤18 years, 63.2%), with an OR of 1.257 (95% CI: 0.678–2.330).

In contrast, the type of therapy regimen showed a significant association with seizure control (p = 0.040). Patients receiving polytherapy demonstrated a higher proportion of poor seizure control (73.3%) compared to those on monotherapy (57.9%), with an OR of 2.000 (95% CI: 1.076–3.717). These results suggest that patients treated with polytherapy were approximately twice as likely to experience poor seizure control as those managed with monotherapy.

The absence of a significant relationship between gender and seizure control is consistent with prior findings. Previous studies, including one assessing the efficacy of oxcarbazepine in pediatric epilepsy, found no significant effect of gender, age, or seizure type on treatment outcomes [33]. Likewise, topiramate has been shown to provide consistent seizure reduction across different age groups, further supporting the non-significant association between age and seizure control observed in this study [34].

However, the significant link between therapy regimen and seizure control corroborates earlier reports that monotherapy tends to result in better seizure management compared to polytherapy [35]. The lower efficacy observed with polytherapy may stem from increased adverse drug effects, pharmacokinetic interactions, and higher treatment burden, all of which can impair adherence and reduce therapeutic benefit.

These findings emphasize that demographic characteristics such as gender and age are not major determinants of seizure control outcomes. Instead, the type of therapeutic regimen plays a more critical role in influencing treatment success. The evidence supports prioritizing monotherapy as the initial management strategy in epilepsy due to its superior tolerability, reduced side effect profile, and lower risk of pharmacological interactions.

Limitations and Future Perspectives

This study has several limitations, including its retrospective nature and single-center design, which limits the generalizability of the prescribing patterns. Furthermore, our analysis of demographic variables, particularly gender differences in prescribing and control, was limited to univariable analysis. We acknowledge that the lack of multivariate adjustment for confounding variables means that the observed associations between gender and prescribing patterns are descriptive and require further investigation using more robust statistical models.

From a clinical perspective, these results underscore the importance of optimizing therapeutic regimens based on individual patient response rather than demographic attributes. Future research should further explore patient-specific and pharmacogenomic factors that may predict treatment responsiveness, while also focusing on prospective studies to track adherence, drug interactions, and the long-term quality of life impacts of VPA monotherapy in children.

Clinicians may consider prioritizing valproic acid monotherapy in pediatric epilepsy when appropriate,

reserving polytherapy for cases with documented pharmacoresistance or inadequate response to initial therapy. Such investigations would provide a more comprehensive understanding of individualized determinants influencing therapeutic outcomes, thereby guiding the development of personalized epilepsy management strategies to maximize seizure control and minimize adverse effects.

Conclusion

This study identified that both monotherapy and polytherapy were prescribed in similar proportions, with valproic acid (VPA) being the most common single agent and phenytoin (PHT) frequently combined with other classic antiepileptics. Monotherapy demonstrated better seizure control compared to polytherapy, indicating that combining multiple agents does not necessarily yield superior outcomes.

Clinically, these findings emphasize the importance of individualized antiepileptic therapy selection, as excessive drug combinations may increase the risk of adverse effects and complicate seizure management. Rational prescribing based on patient characteristics and drug profiles remains essential to achieving optimal control. Future research should focus on prospective randomized controlled trials and pharmacogenomic profiling to clarify predictors of treatment response and guide personalized therapy for epilepsy patients.

Conflict of Interest

The authors have no conflicts of interest regarding this investigation.

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